A Study and Review of Cost Sharing Mechanisms in Multicast Transmission

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Abstract - In this paper, we study the research work of different cost sharing mechanisms in multicast transmission. We also study the performance evaluation of cost sharing mechanisms as the transmission of multimedia content over the internet has become widely accepted. These mechanisms determine which user receives the multicast transmission and how much they have to pay for the service. Shapley Value mechanism and Marginal cost mechanism, were proposed to solve the same. Marginal Cost Mechanism maximizes overall benefit. Shapley Value Mechanism is the most efficient one to budget balanced and cover the cost. The Shapley Value mechanism consists two models SH-TPM (Shapley Value Mechanism for the Tamper Proof Mode) and SH-ANM (Shapley Value Mechanism for the Autonomous Nodes Model). SH-ANM consists SH-ANM-E (Extended) for the verification of cheating node. The phase 2 of SH-ANM-E mechanism is stronger than the phase 2 of SH-ANM.

Keywords - Multicast Transmission, Cost Sharing, benefit.

I. INTRODUCTION

A multicast cost sharing mechanism is being an incentive-compatible individual-rational mechanism with no negative payments. It is also expected that budget balance and efficiency be sought, although it is not possible to achieve both simultaneously. Cost-Sharing Mechanisms having the service provider, a set of potential users such as agents, customers, etc. and each user has a private utility. Cost sharing is the concept of sharing the cost among all of its users or participants and on the basis of availing of services, take the payment from each. Distributed implementations of mechanisms have been proposed for various problems such as multicast cost sharing and scheduling [1]. There are two distributed mechanisms for multicast transmission are there to calculate the cost of the participants in a multicast transmission: the Marginal Cost (MC) mechanism and the Shapley Value (SH) mechanism proposed by Feigenbaum et al. [2]. MC is based on two-phase mechanism and SH is based on iterative mechanism. The MC mechanism is efficient, but it is not budgeted balanced. In many cases MC mechanism does not generate any revenue at all [3].

II. COST SHARING MECHANISMS

Fig 1 Cost Sharing Mechanisms

A multicast cost sharing mechanism is expected to be an incentive-compatible individual-rational mechanism with no negative payments. It is also expected that budget balance and/or efficiency be sought, although it is not possible to achieve both simultaneously. The limitation of the MC mechanism for ANM, given in [4]. MC mechanism considers only one user for one node.

Fig 2. Shows the Marginal cost mechanism for the tamper proof model (MC-TPM) cost sharing consists exactly two messages per link. This is an algorithm that computes the cost shares by considering one bottom-up approach and one top-down approach, and this algorithm is best with respect to the number of messages sent. To authenticate the sender of the messages and use auditing to verify the users they
used the digital signatures. With these mechanisms, SH mechanism has a higher network complexity.

![Fig. 2 MC-TPM Flow Chart](image)

Fig. 2 MC-TPM Flow Chart

Fig. 3 shows a distributed Shapley Value mechanism for sharing the cost of multicast transmissions for the Autonomous Nodes Model, called the SH-ANM.

![Fig. 3 SH-ANM Flow Chart](image)

Fig. 3 SH-ANM Flow Chart

Fig. 4 shows the Shapley Value mechanism for sharing the cost of multicast transmissions of the tamper proof model, called the SH-TPM. In the SH-TPM, bottom-up phase determines the number of users who want to receive the transmission. The bottom-up phase begins from the leaf nodes. The leaf node reports to its parent. Nodes (other than leaf nodes) calculate the payment. Both Mechanisms, SH-ANM and SH-ANM-E mechanism, prevent node deviations, but they are different in their detection capabilities. In Phase 3 of SH-ANM, the nodes are audited so that there is a chance that a cheating node remains undetected. In the SH-ANM-E mechanism, node verifies the values of the cost share value of parent by parent and so there is no possibility of remaining undetected after cheating.

![Fig. 4 SH-TPM Flow Chart](image)

Fig. 4 SH-TPM Flow Chart

In the SH-ANM-E each message sent in the top-down phase, so that it is difficult to cheat. The bottom-up phase is the same as in SH-ANM. The top-down phase is changed by considering grandparent. The SH-ANM-E mechanism gives the higher penalty to that cheated node so that node never tries to do the cheating to the mechanism. The size of message of SH-ANM-E mechanism is bigger as compared to SH-ANM. It involves the extra step of verification of the cost share value of the parent. The administrator of the system has to opt any one of them according to the requirements [5], [6].

III. COMPARISONS of SH-ANM MECHANISM and SH-ANM-E MECHANISM

**SH-ANM mechanism**

- The nodes are audited in phase 3.
- Cheating (If any) will not be detected by the children.
- Cheating may remain undetected.

**SH-ANM-E mechanism**

- Node verification done in phase 2.
- It requires more time for execution because cheating (If any) has detected by the children reporting to root who stop the mechanism.
- No possibility of remaining undetected after cheating.

By considering above comparison, SH-ANM-E is the best mechanism for the cost sharing in multicast transmission as compared with the SH-ANM mechanism. There is a guarantee of cost sharing mechanisms that the users cannot gain any unfair
benefit if the mechanisms follows the proper specification.

IV. CONCLUSION

The marginal cost mechanism is not good as per the content providers view and the MC-ANM considers that there is only one user per node. MC mechanism is efficient and budget balanced at the not same time and SH mechanisms are grouped strategyproof. SH mechanism is better than MC mechanism. SH-TPM does not involve auditing of any node. In the SH-ANM, auditing involves but there are chances of cheating node may remain undetected. In the phase 2 of SH-ANM-E, the verification is performed by children for each node, so there is no possibility of remaining undetected node after cheating. As far as the cheating (if any) is concerned, then the SH-ANM-E mechanism is better and if no cheating is concerned the SH-ANM is best, because SH-ANM requires less time for execution as compared with the SH-ANM-E mechanism.

References